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ABSTRACT

A number of scales have been developed to measure the construct of statistics anxiety, the anxiety students feel when they take a statistics course, but few researchers have examined whether this anxiety is due solely to being enrolled in a statistics course or if there is some component that is simply a function of being a student (anxiety in any course, not just statistics). This study compared responses statistics students and writing students gave to the same course attitude scale, which was created from two existing statistics anxiety scales. Responses were received from approximately 28% of students in three writing and three statistics sections. Response patterns from the two groups were similar, indicating that items created to measure statistics anxiety may be measuring a general "course anxiety" construct instead of being specific to statistics courses. Future research should continue to explore the existing anxiety surveys to determine how "statistics anxiety" is being defined, and how the definition may be made more clear. (Contains 14 references.) (Author/SLD)

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Deconstructing Statistics Anxiety

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Abstract

The statistics education literature is filled with accounts of the anxiety students feel as they take a statistics course. A number of statistics anxiety scales exist to measure this construct. Few authors have examined whether or not this anxiety is due solely to being enrolled in a statistics course or if there is some component that is simply a function of being a student (i.e., a student may feel the test anxiety they report in any course, not just statistics). The purpose of this study was to compare responses statistics students and writing students gave to the same course attitude scale, which was created from 2 existing statistics anxiety scales. Response patterns from the two groups were similar, indicating that items created to measure statistics anxiety may be measuring a general "course anxiety" construct instead of being specific to statistics courses. Future research needs to continue to explore the existing anxiety surveys to determine how we are defining "statistics anxiety," and how we might make that definition more clear.

Research on statistics anxiety has been conducted for decades. Over the years, many variables have been found to relate to the traditionally high levels of anxiety we see in introductory statistics courses. However, one question that has not been asked until very recently is how well we are actually defining *statistics anxiety*. At least six instruments exist that are designed to measure this anxiety: STARS (Cruise, Cash, & Bolton, 1985), SATS (Schau, Stevens, Dauphinee, & Del Vecchio, 1993), SAS (Roberts & Bilderback, 1980), ATS (Wise, 1985), STATS (Rogness, 1993), and STATS (Sutarso, 1992). There are of course many others, but these seem to be those most often cited in the statistics anxiety literature.

Cashin and Elmore (1997) reviewed several of these instruments that researchers have used to measure statistics anxiety. Although they found sufficient evidence of these instruments' reliability and validity, they did not compare scores on these instruments or determine if, in fact, all of these instruments are indeed measuring the same construct (i.e., an assessment of concurrent validity).

Of particular concern at this point is whether or not scores on these instruments measure "statistics anxiety" or some other form of anxiety. For example, some anxiety instruments include questions related to taking a statistics test. Do we know if these questions are indicators of *statistics anxiety* or *test anxiety*? Although test anxiety may increase the anxiety students feel in a statistics course, general test anxiety is not necessarily

created by the statistics course. Other statistics anxiety instruments ask questions about the use of computers or calculators. Again, although students may express these anxieties, they only increase anxiety in a statistics course – the course content itself has not created these anxieties.

The purpose of this line of questioning is entirely motivated by a practitioner focus. If, as a statistics instructor, I am to reduce "statistics anxiety," how will scores on these instruments help? What exactly *is* statistics anxiety? Is it combination of other anxieties students have (Onwuegbuzie, 1998), all coming together in statistics to an overwhelming and potentially failure-inducing level? Are there any aspects of this anxiety that are *directly related* to the statistics experience (Onwuegbuzie, DaRos, & Ryan, 1997)? If so, what are they? What can we as statistics instructors then do to reduce or eliminate them? If statistics anxiety is actually an additive construct, a combination of other types of anxiety, then how can we as instructors reduce or eliminate what is not under our control? If a student expresses high test anxiety, then it will not matter what kind of test a professor uses in class – students will still be anxious. If students are always anxious about using computers and calculators, then how can this be reduced or eliminated by a statistics professor? This discussion is indeed informed by the state-trait dichotomy found in more general anxiety research (Tremblay, Gardner, & Heipel, 2000). Is anxiety reported by statistics students a

function of their "state" (being in a statistics course) or a more general "trait" type of anxiety?

The purpose of this study, therefore, is to begin exploring in more detail the content of statistics anxiety instruments (and, therefore, how we are defining statistics anxiety) by analyzing responses from students in an introductory statistics course and comparing these responses to those from students in an introductory writing course. The goal is to begin evaluating the discriminant and concurrent validity of all of the existing statistics anxiety scales by focusing on just two. The specific research questions are: (a) Are scores from two statistics anxiety instruments correlated in a way that indicates strong concurrent validity, and (b) Can we distinguish writing students from statistics students based on their responses to the same anxiety scale? The study reported here is a pilot study, and the results are meant to begin a dialogue that we hope will continue with further research.

Methods

Participants

In the Spring 2002 term, the researchers contacted the directors of the English 112 introductory writing course and the Math 115 introductory statistics course to obtain permission to deliver surveys to randomly selected sections. Directors and section instructors gave access to 15 writing sections and 18 statistics sections. From each course, we randomly selected 6 sections for recruiting students.

Course instructors in the 12 selected sections delivered the surveys during class in one of two formats: paper-and-pencil or web-format. The reason for this was to explore (in a separate study) the psychometric properties of web-based versus traditional paper-based surveys. A script was provided for instructors to read after handing out letters to their students introducing the survey. Six of the twelve sections (three writing, three statistics) received the paper-based survey and the other six received instructions for accessing and completing the web-based survey. Students were asked to complete the surveys within two weeks.

Approximate response rates were low, approximately 28%. These are approximate because we are not 100% certain all of the math sections received the survey. Poor communication with these instructors, coupled with the fact that only 12 math students responded, prompted us to redesign our delivery methods for the full study to be conducted Spring 2003. We do know all six of the English 112 sections received the survey, and 28% of these students responded. We chose to use this as a high approximation of our overall response rate, with the understanding that it is most likely much lower than this.

Instrumentation

In order to begin exploring the various statistics anxiety instruments in more depth, items from two instruments measuring student attitudes toward statistics, both called the STATS (Rogness, 1993 and Sutarso, 1992)

were collapsed into one instrument, which we called the Course Attitude Scale. These two scales were selected for this first round because they were readily accessible to the authors. Duplicate items or items with similar wording to others were removed, for a total of 56 unique items in the final scale. The overall reliability of the data from this study came out to be $\alpha = 0.91$.

All items on the new scale were re-worded to be generic to any course, not just statistics. So, an item such as "If I were not required to take a statistics course for my major, I wouldn't take one" was changed to read "If I were not required to take THIS COURSE for my major, I wouldn't take it." The purpose of the study reported here was to pilot test this new instrument and our survey delivery methods.

Results

First, we correlated scores from the two instruments for evidence of concurrent validity. Pearson's r came out to 0.74, indicating strong concurrent validity, and the instruments appear to be measuring the same construct.

Second, as individual items are ordinal in nature, we used Mann-Whitney U tests to compare the item response patterns of writing students and statistics students. Items that come out significantly different indicate the response patterns for the two groups were not similar – results from these tests can give us a start to exploring which items may be related

specifically to taking a statistics course and which are not necessarily statistics-specific. Of the 56 items on the instrument, only three came out with significantly different response patterns: "My mother likes/liked this subject, so I will," "This course will improve my research ability," and "I try to do as little work as I can in this course." Looking at cross-tabulations of the responses for each item, the similarity in groups is confirmed. These results indicate that the instrument is not doing a good job distinguishing writing students from statistics students. From this, we begin to question whether the items are measuring any statistics-specific anxiety at all.

Discussion

Specific item analyses on just two of the myriad statistics anxiety instruments should provoke discussion about the way in which we define statistics anxiety. Are we truly measuring something unique to statistics, or is this construct a more general type of anxiety (Frey & Cashin, 2001)? This is an attempt to provide a more detailed description of a phenomenon researchers have studied for decades and one that statistics instructors grapple with daily. In order to provide practitioners with more directed advice about how to reduce anxiety (and therefore remove a very large barrier to learning statistics (Onwuegbuzie & Seaman, 1994; Tremblay, Gardner, & Heipel, 2000; Zeidner, 1991)), we need to be clear about what scores on statistics anxiety surveys are actually telling us about what *statistics* students struggle with most. In our study, writing students

responded the same way to nearly all of the items as statistics students did. From these results, it seems more likely that we are measuring some general "classroom" anxiety as opposed to statistics-specific anxiety.

An important step in the evaluation of these items will be to add interview or focus group data to the current literature. In these discussions with current statistics students, each item can be evaluated as to whether or not it makes sense as an indicator of statistics anxiety. Students can also help us discover new questions we may not be asking, or new ways to ask the questions we already have (Piotrowski, Bagui, & Hemasinha, 2002). Discussions with statistics instructors to evaluate their own classroom observations (e.g., "When do you believe students are most anxious?") should also help us re-evaluate how and when we measure statistics anxiety so that more practical classroom-based interventions can be developed.

Given the proliferation of statistics anxiety scales, it also seems important to pause and evaluate whether or not they are all measuring the same construct. There is evidence that both instruments included in this study are measuring the same idea, but what exactly it is they are measuring is still in question. Future studies should incorporate more of the statistics anxiety instruments currently in use (e.g., STARS, SATS, ATS, SAS) to further evaluate their concurrent validity. This continued evaluation should further assist us in defining the uniqueness of statistics anxiety.

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